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FIELD SURVEY OF POTENTIAL RIPRAP

QUARRY SITES IN THE CAMPBELL LAKE AREA

by

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CALGARY, Alberta
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INTRODUCTION

Several reports, based on field inspections and mapping by Imperial Oil Limited and officers of the Geological Survey of Canada, discuss the geology near the Beaufort Coast.

The geological information from these reports has, in the past, been summarized and submitted to the Field Services Department of Imperial Oil for use in support of an application (Land Use Committee - Department of Indian Affairs and Northern Development) to establish a rock quarry in the Campbell Lake area. The riprap will be used as slope protection material for permanent all-weather facilities and, as such, the source rocks must have physical and structural properties that cause them to break into large blocks of durable stone.

The most recent of these summary reports, "Suitable Riprap Sources Near Inuvik, N.W.T." was written by J.W. Zaturecky (January 28, 1976). This report indicates that rock in several localities in the Rocky Hills - Campbell Lake area south of Inuvik are of sufficient high-quality for use as riprap.

Potential Riprap Sources

During the past four years, Imperial Oil geologists have suggested several potential riprap sources near the Beaufort Coast between Mt. Sedgwick in the west to Cape Lyon in the east. At most of these localities, the rock type is either unsuitable for quarrying or the locality is so remote that quarrying and transportation would be very expensive.

Flaggy to thick-bedded quartzite, quartzose sandstone and conglomerates occur in the Aklavik Range and in the British and Barn Mountains. Localities at Mount Goodenough, along Donna River and Martin Creek in the Richardsons and along the Babbage and other rivers draining the West Coastal Plain were field-checked in 1974 (Figure 1). These weak, friable, rocks are highly susceptible to frost-shattering which generally produces a scree of very fine, platy, rubble that either disintegrates or shatters into splinters when disturbed. Small stocks of intrusive igneous rock occur at Mt. Fitton in the Barn Mountains and at Mt. Sedgwick in the British Mountains. These igneous rocks are light-colored, coarsely porphyritic granites which have been tectonically stressed and fractured by geological events occurring after their emplacement. Frost-action on these rocks produces fine, splintery, spalls which are not necessarily indicative of their quarrying qualities. This is because it takes much longer for granites to produce an equivalent amount of rubble by natural weathering than would be true for a quartz

sandstone under the same conditions. However, the heterogeneous nature of granitic rocks, in general, makes blasting impractical as a means of retrieving rubble suitable for riprap. The stressed and jointed nature of the granites at Mt. Fitton and Mt. Sedgwick further suggests that conventional quarrying techniques are not likely to produce significantly better results than blasting.

East of Inuvik the first occurrences of firm bedrock at, or adjacent to, the Coast are in the Paulatuk region; at Parry Peninsula; up the Hornaday Canyon and near Cape Lyon. At the first two localities, there are thin-to-medium bedded dolomites and dolomitic limestone similar in appearance and identical in age with those in the Rocky Hills along the northwest side of Campbell Lake. Argillaceous dolomites, similar to those at the M.O.T. quarry near Inuvik where they are strongly cleaved and fractured and break up into relatively fine material, occur at Cape Lyon proper. A few miles inland there are dolomites, quartzites and doleritic dykes and sills. This same sequence of rocks occurs at the southernmost tip of Banks Island. Quarrying and extraction in these localities would be very expensive due to their remoteness and the fact that most rock types are unsuitable for blasting as a result of their natural properties.

SUMMARY OF 1976 FIELD SURVEY DATA

A general survey of the Campbell Lake area was undertaken in June, 1976, and a careful investigation was made of several outcrop localities to further assist in estimating the quality of rock for quarrying operations. The primary purpose of these inspections was to observe and record structural properties such as bedding and jointing which outline the potential size of rock fragments in an outcrop. Descriptions, samples and/or photo-

graphs were taken at all localities visited.

The following comments and photographs summarize the data collected during this survey and should be used as a supplement to earlier reports by J.W. Zaturecky.

Geological Setting

The Campbell or Rocky Hills (Figure 2) is a local plateau of rugged terrain that was subjected to tectonic activity and uplifted during the Paleozoic (L. Devonian) and strongly rejuvenated during Late Cretaceous (Laramide) time. Rocks ranging in age from Precambrian to Devonian, including quartzites, quartzitic sands, dolomites and limestones are exposed. Bedding thickness in these different rock types varies from thin (1') to thick (3') and is occasionally massive (>3'). The area is complexly-faulted as a result of the tectonic activity and most outcrops exhibit vertical jointing with variable spacing (average 2 - 3 feet).

Locations inspected and/or photographed during the 1976 field survey are shown on the surface compilation map (Figure 3) which shows the bed rock geology as mapped in the Campbell Lake area.

OUTCROP DESCRIPTIONS (1976)

East Channel Quarry Area

This is a relatively low-lying area with several outcrops of

dolomite having relief in the order of 30 to 50 feet and up to 100 feet in places. Two quarry sites have been proposed in this area.

1. Site No. 1: This outcrop is about 30 feet above water and consists of dolomite which is light-grey, coarsely crystalline, thick-massive (2' - 3'), very hard and dense. Vertical joints have spacing in the order of 2 feet. Test blasting has given rock of various size with some as large as 3' x 2' x 2'.

2. Site No. 2: This outcrop is located to the east of Site No. 1 and also consists of dolomite - light - medium grey, coarsely crystalline, thick - massive bedded (2' - 3'+), very hard and dense. Vertical jointing is common and some small healed fractures are noted. Test blasting here appears to have given smaller material than at Site No. 1.

OUTLIERS OF BEDROCK TO SOUTHWEST

Outlier East of East Channel

A stop was made in the northern part of this large outlier. Most of the southern portion of this area is covered and the area to the north consists of many N - S aligned low-relief outcrops 20 - 30 feet high and some up to 50 feet high. Outcrops to the west of the one inspected looked more massively bedded and had a couple of large broken blocks at the foot of the outcrop.

Site No. 3: This outcrop is about 50 feet above water and consists of dolomite - dark-grey, microcrystalline, thin - massive bedded (1 - 3 feet), hard and dense. Vertical jointing exists and the rock, on closer inspection, is commonly fractured with most of the fractures healed with coarser dolomite.

Outlier West of East Channel

Relief of outcrops in this area is in the order of 30 feet above water.

Site No. 4 outcrop is limestone, medium to dark grey, varies from skeletal micritic to skeletal (crinoidal), thin - thick bedded (1 - 2 feet), hard and dense or non-porous. The rock exhibits jointing and is commonly - highly fractured (healed) at surface. Rubble at the base of outcrops is generally small; however, occasional fragments are as large as 2' x 3' x 2'.

Small Outlier to West of Kalinek Channel

Most of this area is below water with an occasional outcrop, presumably of limestone, rising about ten feet above water.

Dempster Highway Borrow Pit (South of Campbell Lake)

Site No. 5: This borrow pit consists of thinly-interbedded, dark grey to black fissile shale and grey to dark grey silty shales or siltstones of the Imperial Formation (Devonian). These rocks would not be suitable for riprap.

Outcrop East Side of Campbell Lake

Site No. 6: The cliffs and high area above the southeast shore of Campbell Lake consist of thick - massive bedded limestone, medium to dark grey, hard and dense. Vertical jointing (3' spacing) is common and in places the rock appears quite fractured. Again, most fractures are healed and should not severely affect the quality of the rock. Talus on the slopes includes a few very large blocks of rock.

Outcrops to the northeast of the #6 stop also contain thick - massive bedded, jointed, carbonate with some large fragments in the talus.

Dempster Highway Quarry

Devonian limestone is being quarried at the northwest end of Campbell Lake. Large blocks (4' x 3' x 3') are not uncommon in the material that has been pushed aside in this quarry.

Site No. 7: The outcrop here consists of limestone, dark grey - black, skeletal micrite, thick to massive bedded, hard and dense. Thin section analysis shows a high percentage of bitumen (20%) plugging. Another type of limestone, which is micritic - skeletal (brachiopods), has less bitumen and is probably denser than the above limestone. Vertical jointing is present and some fracturing appears on one quarry face, however, this may be blast-induced.

North of East Channel Quarry

Quartzites and quartzitic sands are present north of the proposed

dolomite quarry area. The quartzitic sands are hard but somewhat friable and probably would not be as favourable as the quartzites for quarry rock.

Site No. 8: Quartzite outcrop cliffs. This rock is light grey - flesh colored, thick - massive bedded, silica cemented, very hard and dense. Vertical jointing (2' - 3'+ spacing) is very obvious from the air. The rock has many healed fractures; however, these may not prevail at depth or affect the quality of rock for riprap.

CONCLUSIONS RE STRUCTURAL PROPERTIES AND QUALITY OF ROCKS

The various rock types were compared to the dolomites in the proposed quarry sites and rated, based on surficial structural (bedding, jointing, fracturing) and physical (hardness, density) properties. The Table (Figure 3) summarizes and compares the properties of the various rock types and is an initial attempt at rating the quality of rock for quarrying purposes. The hardness and density values quoted are estimates only. Density values were estimated, based on matrix density of various minerals. The property of fracturing was considered because fractured rocks would have a greater tendency to shatter when blasted which would reduce their potential for large riprap.

Based on field observations and the assessment of two of the most important structural qualities, i.e., bed thickness and joint spacing

(average 2 feet), all of the carbonates and quartzites have the potential, when blasted, to provide some large riprap even though it may be a small percentage. The dolomites in the proposed East Channel quarry area and the quartzites to the north appear to have the best potential for riprap. It should be emphasized that even the best blasting technique will not produce large stone if the rock in place exists in small pre-determined pieces. Outcrops with thinner bedding, such as Outliers #3 and #4, will not have the potential for as much large material as other outcrops.

RECOMMENDATIONS

Other tests, in both laboratory and field, may be required to ascertain the physical and structural qualities of the various rock types.

Laboratory tests which measure hardness, compressive strength and density, should be conducted on random samples of the various materials available. Freeze-thaw experiments should also be carried out to compare the behaviour of these different types with each other and against standard specimens of concrete. On-site blast testing, in some of the other localities, is recommended.

DJG & JWZ/jw
CALGARY, Alberta
August 4, 1976.

ESTIMATE OF ROCK PROPERTIES AND QUALITY RATING -- ROCKY HILLS

	ROCK TYPE	BEDDING	JOINTING	*FRACTURES (healed)	HARDNESS	DENSITY (Pb)	RATING
EAST CHANNEL QUARRY #1	Dolomite	Thick-massive 3	X 3	Trace 3	Very hard 3	2.85 3	<u>15</u>
#2	Dolomite	Thick-massive 3	X 3	Trace-common 2.5	Very hard 3	2.85 3	<u>14.5</u>
OUTLIERS S.W. #3	Dolomite	Thin-massive 2	X 3	Common 2	Hard 2.5	2.85 3	<u>12.5</u>
#4	Limestone	Thin-massive 2	X 3	Common-Abundant 1.5	Hard <2	2.7 2	<10.5
DEMPSTER PIT #5	Shale & Siltstone	Very thin	(N. Obs.)	(N. Obs.)	Brittle & Soft	---	N.S.
EAST CAMPBELL LAKE #6	Limestone	Thick-massive 3	X 3	Common 2	Hard <2	2.7 2	< <u>12</u>
DEMPSTER QUARRY #7	Limestone	Thick-massive 3	X 3	Common 2	Hard <2	2.35-2.55 1	<11
OTHER #8	Quartzite	Thick-massive 3	X 3	Common 2	Very hard 3	2.65 2	<u>13</u>

Key:

*RATINGS: 1 - 3 (1 = poor; 2 = average; 3 = good)

N.S. NOT SUITABLE

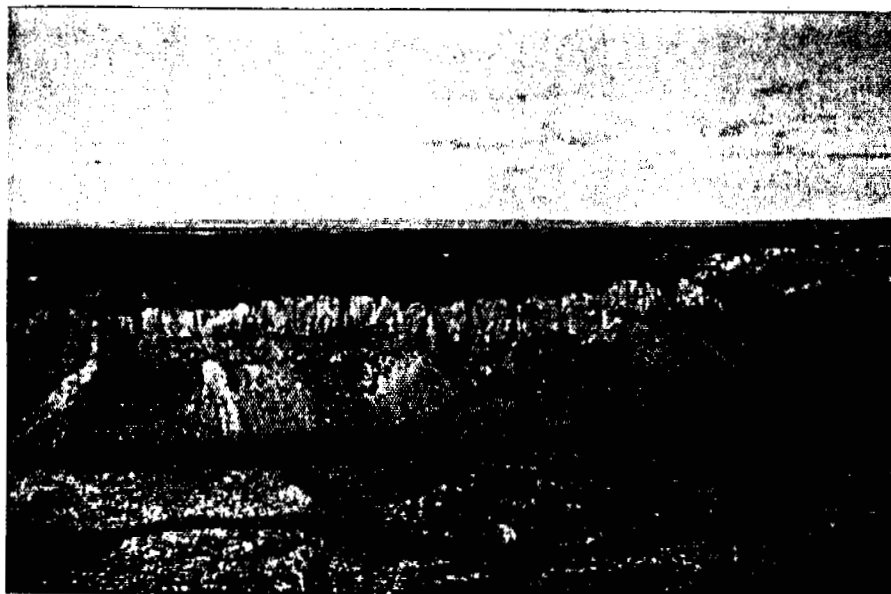
N. Obs. Not observed

FIG. 3

PLATES 1-19

EAST CHANNEL QUARRY

Plates 1 - 6



300'

#1 Dolomite outcrops in low lying area south southeast of massive quartzite cliffs.



#2 A higher relief (50'-100') dolomite outcrop in East Channel Quarry.

EAST CHANNEL QUARRY



#3 Site 1 Thick-massive
bedded dolomite.



#4 Site 2 Test blast - large dolomite
blocks at foot of outcrop.

EAST CHANNEL QUARRY



#5 Site 2 Test blasted - thick bedded dolomite.



#6 Another test blast site - a few large dolomite fragments.

OUTLIERS TO SOUTH - SOUTHWEST OF
EAST CHANNEL QUARRY



#7

Low relief (30'-50') dolomite
outcrops in the northern portion
of large outlier south of East
Channel Quarry.



1'

#8 Site 3

Thick-massive bedded dolomite
with some surficial fractures.

OUTLIERS TO SOUTH - SOUTHWEST OF
EAST CHANNEL QUARRY



#9 Site #4

Thin-thick bedded,
fractured limestone
outcrop in outlier
immediately west of
East Channel.

DEMPSTER HIGHWAY BORROW PIT

Plate 10



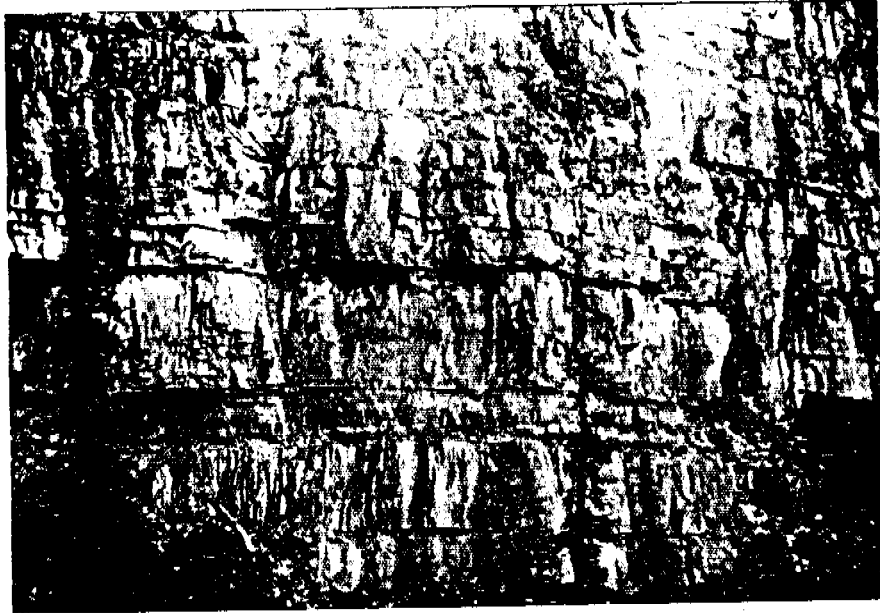
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#10 Site 5

Dark grey-black, fissile-platey, shale with thin interbeds of grey siltstone (Devonian Imperial Fm.) in a highway borrow pit south of Campbell Lake.

OUTCROPS SOUTHEAST OF CAMPBELL LAKE

Plates 11 - 13



5'

#11

Massive bedded limestone cliffs
southeast side Campbell Lake.



6'

#12 Site 6

Open joint in massive bedded
limestone at outcrop on top
of cliffs. (joint spacing
3' - 4')

OUTCROPS SOUTHEAST SIDE OF CAMPBELL LAKE



#13 Outcrop northeast of Site #6 (southeast of Dempster Highway). Large rock fragments from thin - massive bedded, jointed, limestone.

DEMPSTER HIGHWAY QUARRY

Plates 14 - 17



#14 Site 7

Dempster Highway Quarry from
air - note large rock fragments
in front of and at entrance to
quarry.



4'

#15

Large limestone blocks near entrance
to quarry.

DEMPSTER HIGHWAY QUARRY

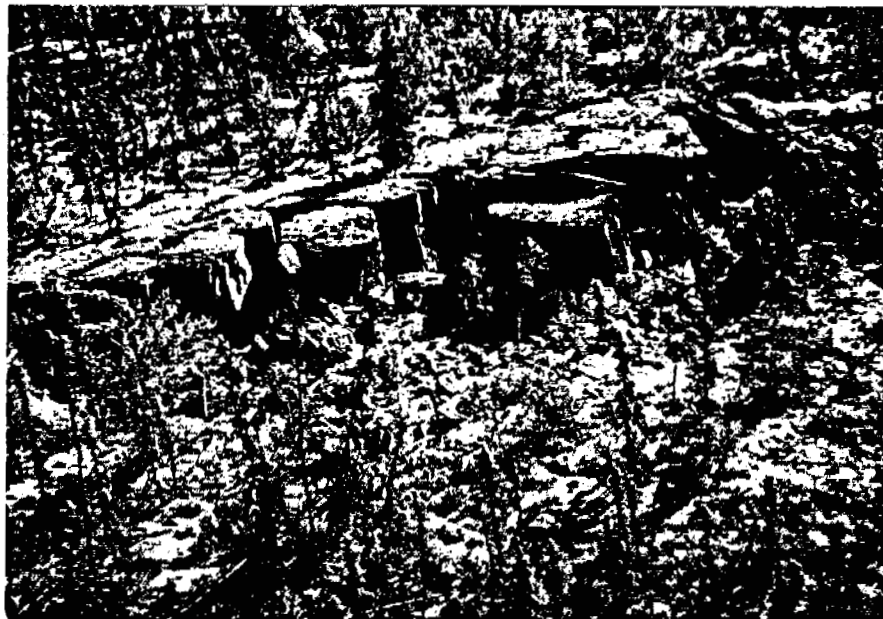


#16 Blasted Wall - thin-thick bedded, fractured, limestone (some fracturing may be blast induced)



#17 Massive appearing quarry wall.

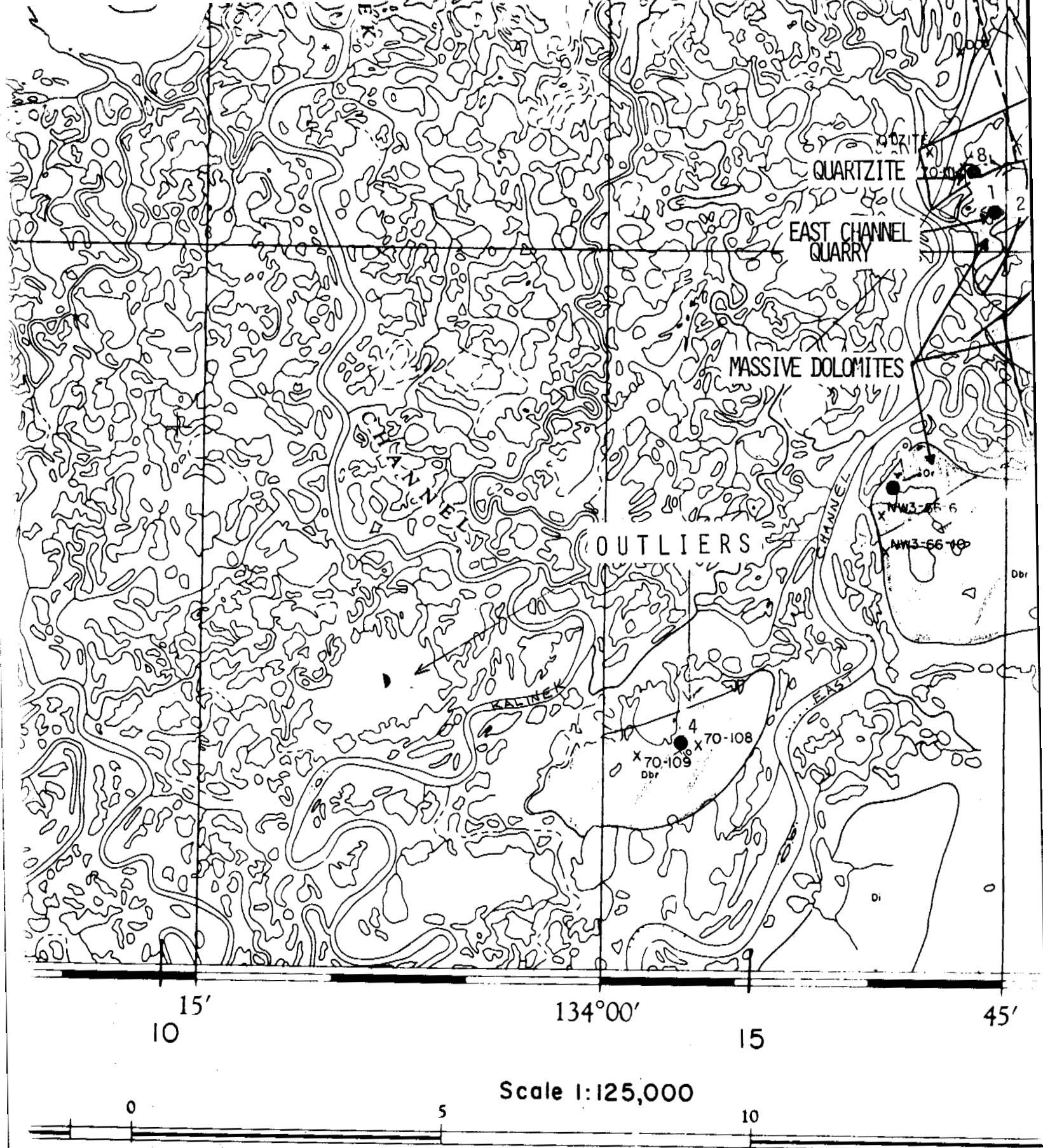
QUARTZITES NORTH OF EAST CHANNEL QUARRY
Plates 18 - 19



#18 Site #8 Thick-massive bedded quartzite
with wide joint spacing.

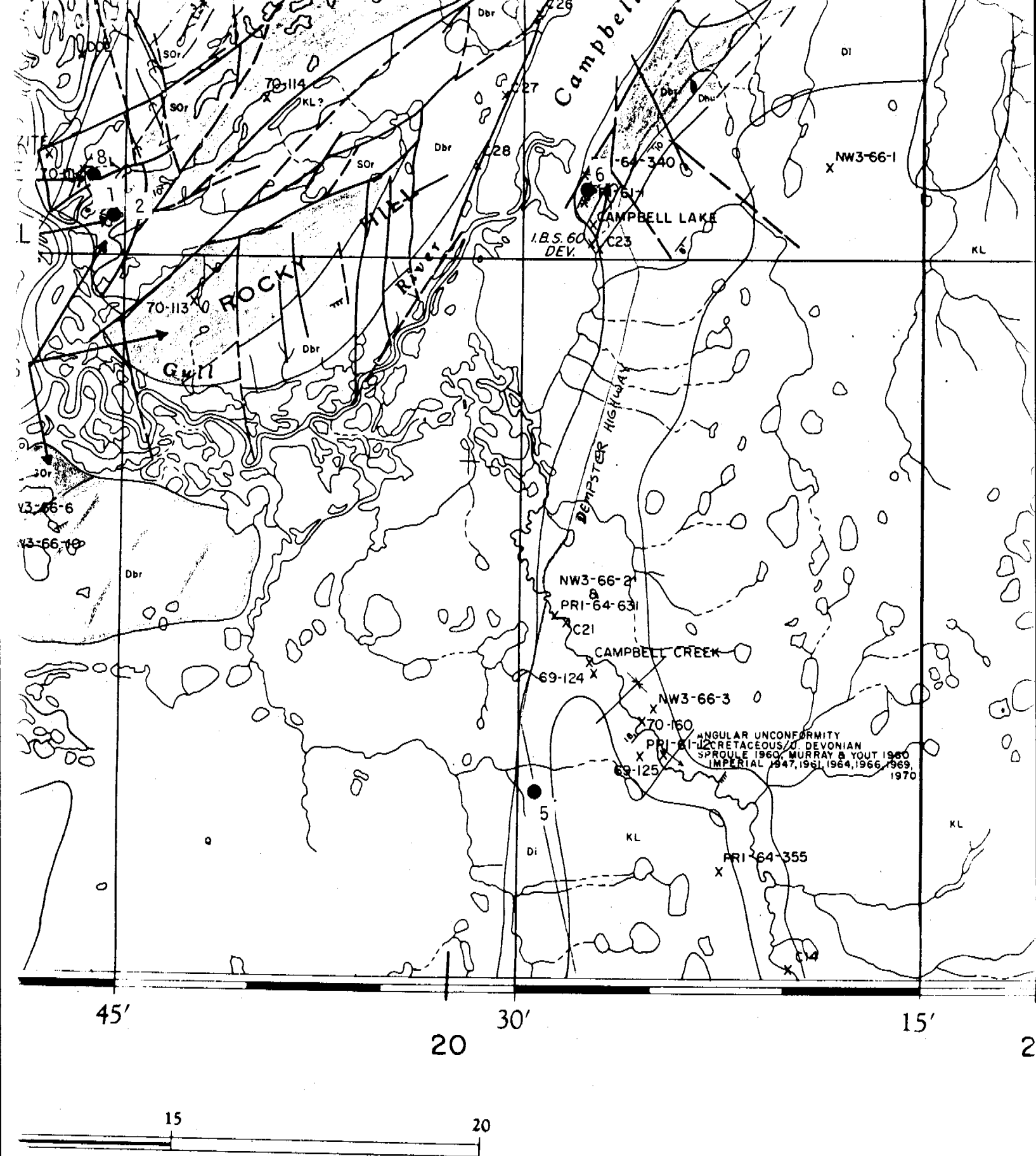


#19 Another quartzite outcrop
exhibiting wide spaced jointing
and thick-massive bedding.

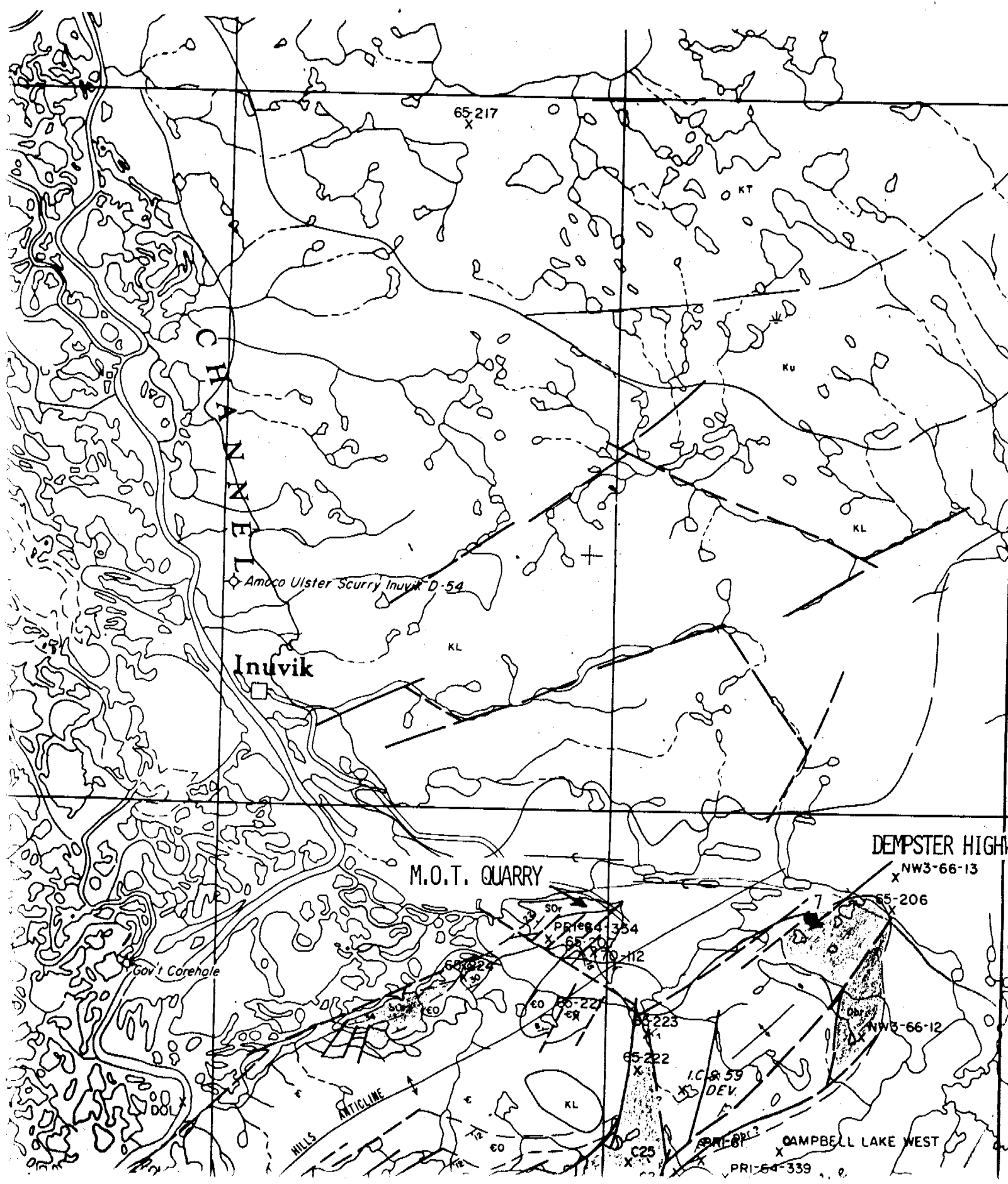


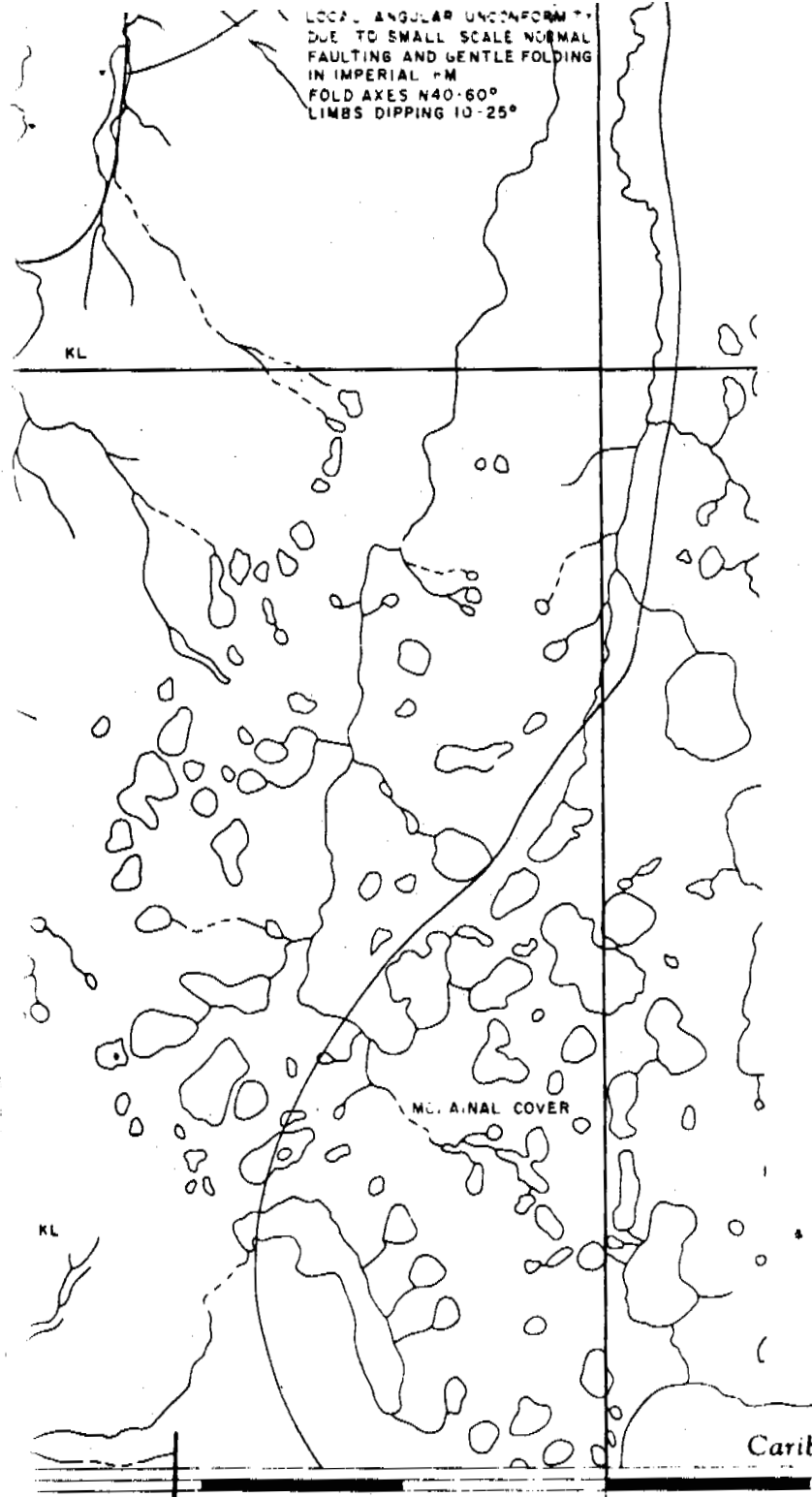
tes, Territorial Plane Coordinate System.
Projection, 6° Zone

Basic map reproduced from N.T.
Mapping Branch, Department of



ed from N.T.S. series, produced by Surveys & Department of Energy, Mines & Minerals





- CRETACEOUS**
- Ku** UPPER CRETACEOUS UNNAMED CENOMANIAN
- K** LOWER CRETACEOUS UNNAMED NEOCOMIAN
- UPPER DEVONIAN**
- Di** IMPERIAL FORMATION INTERBEDDED SANDSTONE AND SHALE
- MIDDLE DEVONIAN**
- D** BEAR ROCK CYCLIC LIMESTONE, SHALE, LIMESTONE PHASES ARE SEPARATED BY ORGANISMS
- Dbr** BEAR ROCK LIMESTONE, MAINLY MICRINURINID
- SILURIAN AND ORDOVICIAN**
- SOr** RONNING GROUP DOLOMITE
- LATE CAMBRIAN AND (?) ORDOVICIAN**
- eo** DOLOMITE AND ARGILLITES
- CAMBRIAN**
- ε** UNNAMED CLASTIC UNIT, QUARTZITE
- PRECAMBRIAN**
- P** PROTEROZOIC BASEMENT, SLATY ARGILLITE, DOLOMITE
- Locations sampled and photographed June 1976
- ◆ Locations photographed only June 1976

SURFACE GEOLOGICAL COMPILATION

NOTE: Print with surface geological overlay only.

IOUS

D CENOMANIAN TO MAESTRICHTIAN

D NEOCOMIAN TO ALBIAN

ONIAN

RBEDDED SHALE & CROSSBEDDED SANDSTONE

VONIAN

NE, SHALE, LIMESTONE. UPPER LIMITS OF THE
SES ARE SKELETAL HAVING COLONIAL (CORAL)

AINLY MICRITIC

ORDOVICIAN

(?) ORDOVICIAN

ES

AN

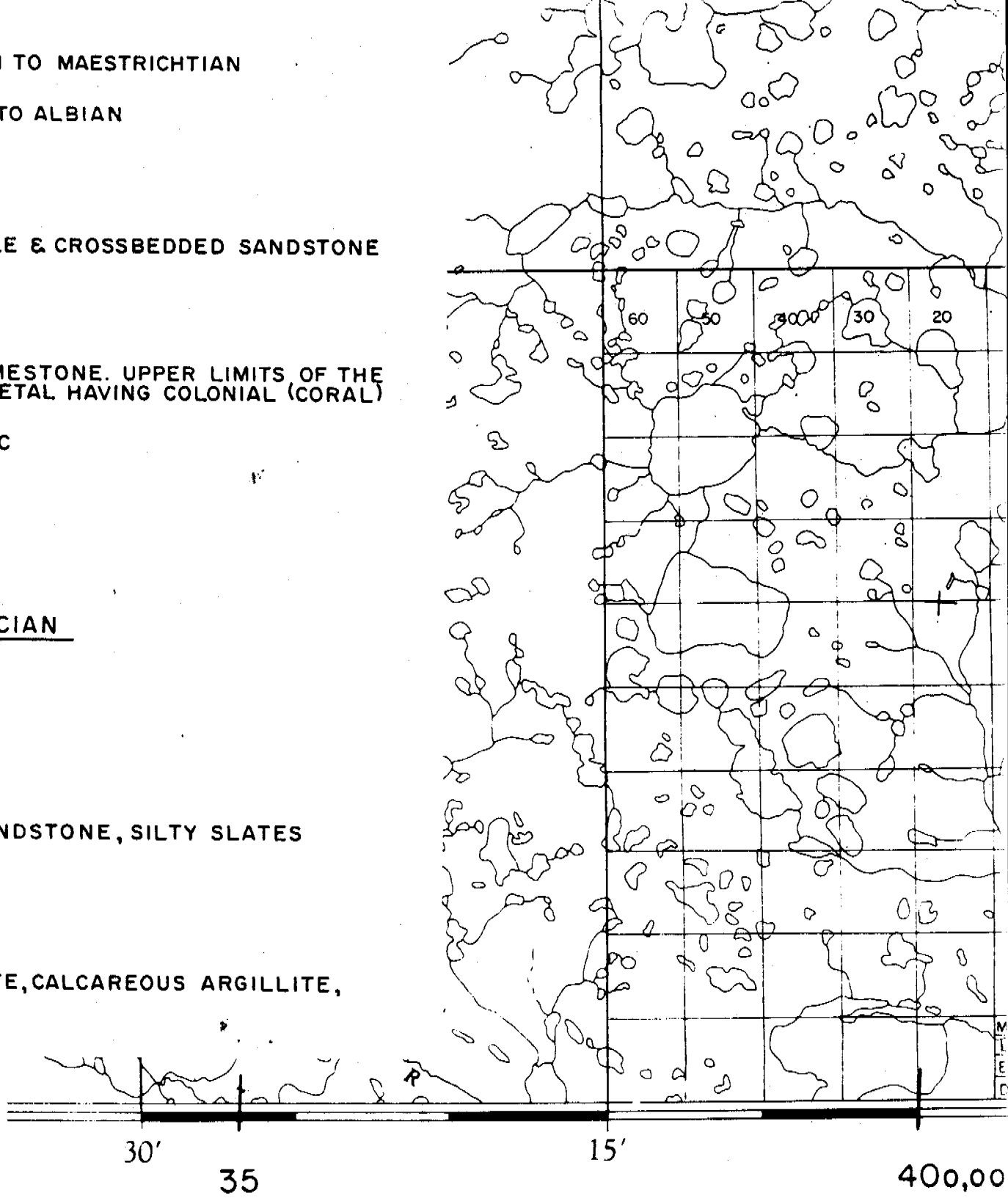
QUARTZITE, SANDSTONE, SILTY SLATES

RIAN

ATY ARGILLITE, CALCAREOUS ARGILLITE,
LOMITE

hed June 1976

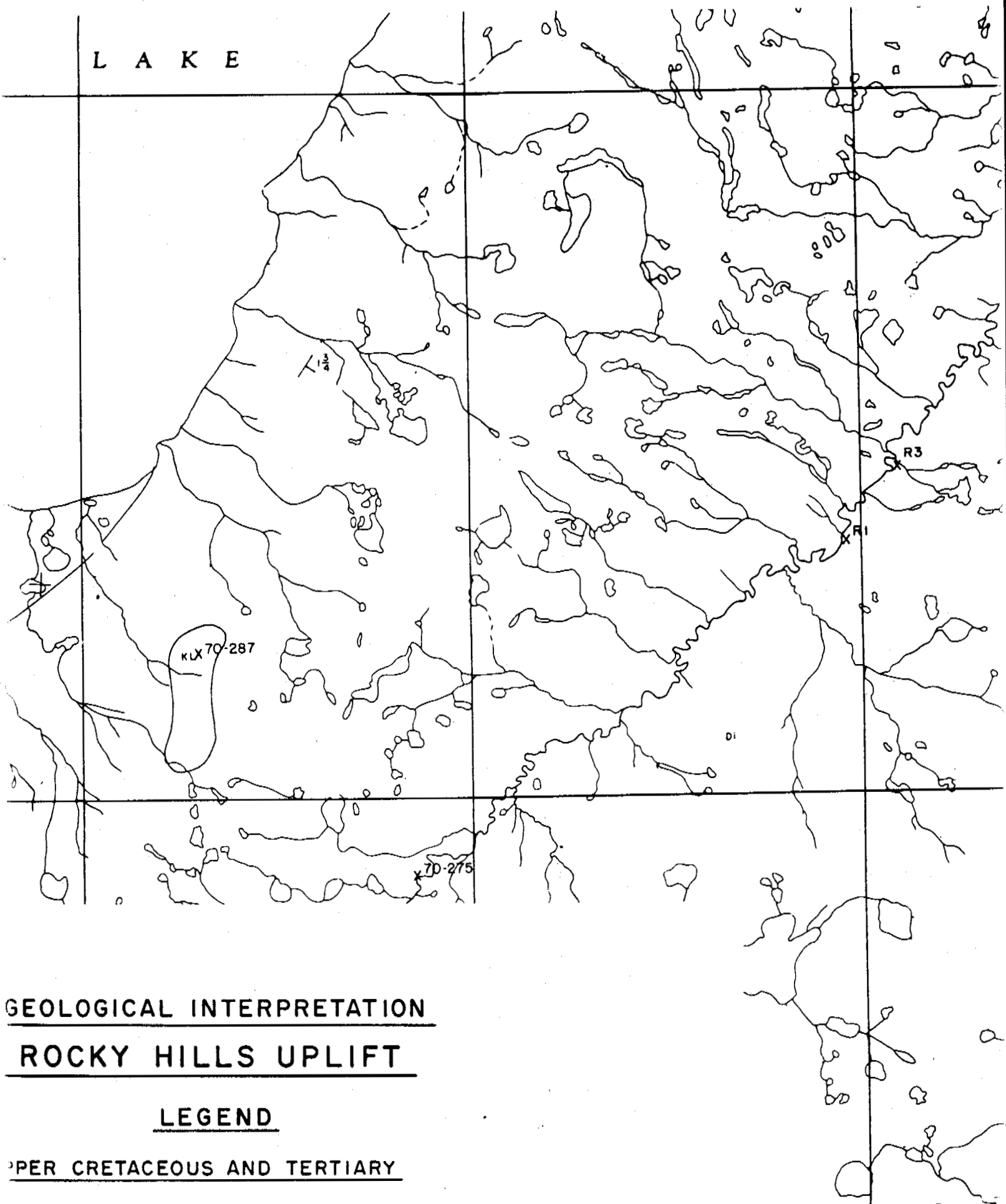
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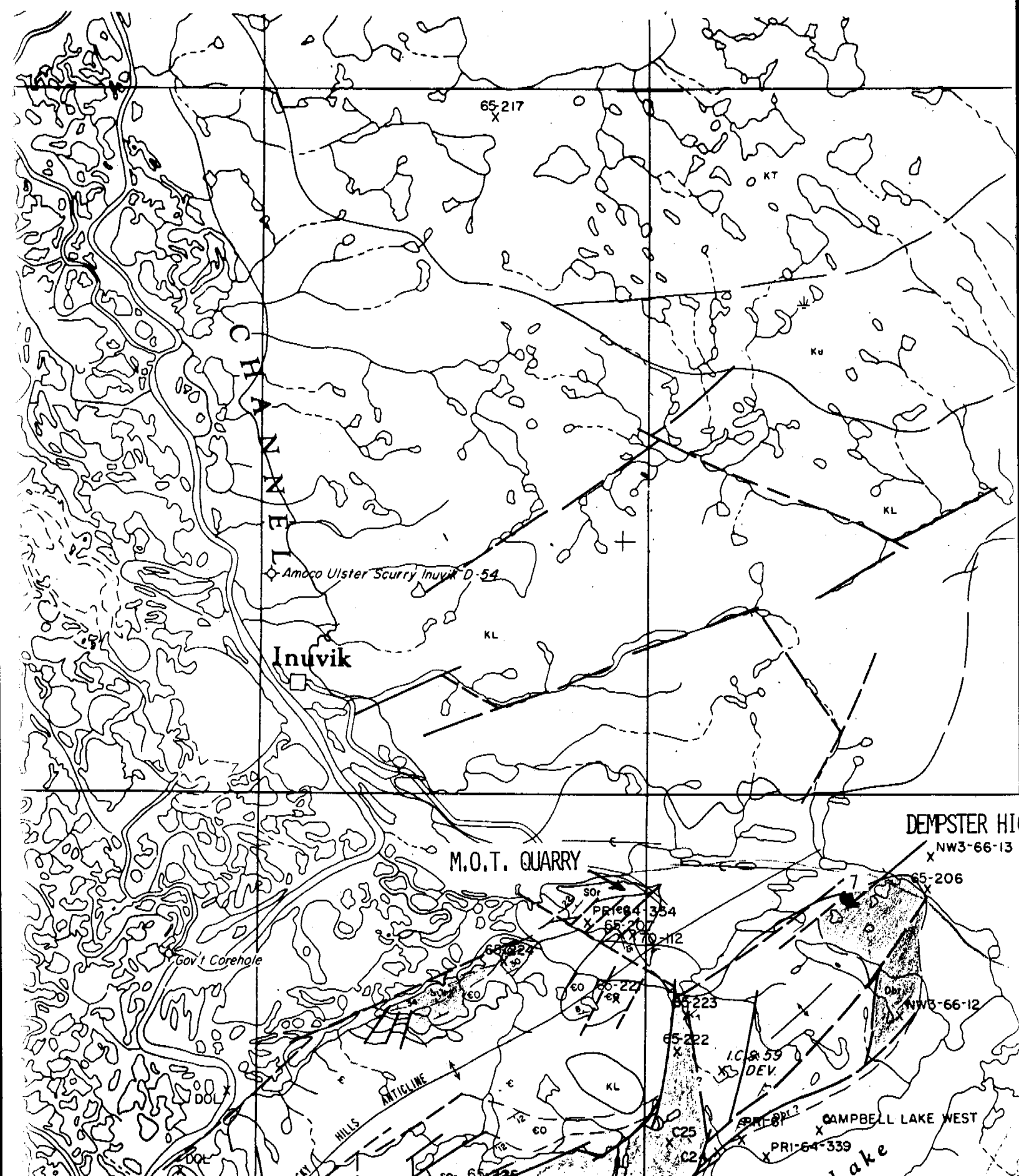


GEOLOGICAL INTERPRETATION

ROCKY HILLS UPLIFT

LEGEND

PER CRETACEOUS AND TERTIARY



L A

x65-706

69-126

x65-201

65-200

Ku
(Δ Kbi)

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1-1 $\frac{1}{2}$

7 $\frac{1}{2}$

DEMPSTER HIGHWAY QUARRY

xNW3-66-13

65-206

NW3-66-12

LAKE WEST

x70-267

KL

Di

GEOLOGICAL

ROCKY MOUNTAINS

UPPER CRETACEOUS

